

## 1 APPARATUS AND METHOD FOR HARVESTING BONE

2 The present invention relates to the field of surgery. The invention has  
3 particular utility in connection with the removal and collection of bone (harvesting)  
4 from the surface of one or more donor sites, and the preparation and placement of the  
5 autogenous bone material at a location in the patient, e.g. for use in grafting bone to  
6 osseous deficiencies, such as periodontal and dentoalveolar defects, bone deficiencies  
7 around dental implants, and numerous orthopedic applications that require grafting,  
8 and will be described in connection with such utility, although other utilities are  
9 contemplated.

10 Many reconstructive procedures used in medicine and dentistry involve the  
11 manipulation and healing of bones. Such procedures may involve changes in the  
12 position, orientation, shape and size of skeletal structures. A problem that is  
13 commonly encountered during such procedures is a lack of bone graft material. Bone  
14 graft material may be used in several applications, such as to fill between sections of  
15 bone that have been repositioned, to change surface geometry, or to add bone to an  
16 area that is deficient, such as in conjunction with periodontal surgery or dental  
17 implants in the patients' jaws.

18 The need to harvest small bone grafts from intraoral sites has been common in  
19 periodontal surgery to restore bone defects around teeth. In the case of dental implant  
20 surgery, bone grafts may be needed to augment atrophic alveolar ridges of the maxilla  
21 and/or mandible and the sinus floor to increase the dimension of these bone sites to  
22 accommodate and totally cover the endosseous portion of implant fixtures. Bone  
23 grafts also are used in conjunction with guided tissue regeneration; a technique that  
24 uses a membrane to isolate hard tissue from soft tissue sites and potentiates hard  
25 tissue healing.

26 It is often difficult to harvest adequate amounts of autogenous bone from  
27 intraoral sites. Therefore, clinicians often rely on non-autogenous sources of graft  
28 material, such as bone from cadaver sources (allografts or allogenic grafts), animal  
29 sources (xenografts or xenogeneic grafts), or synthetic bone substitutes (alloplasts).  
30 However, healing of non-autogenous material grafts is not as extensive or predictable  
31 as healing of autogenous bone; plus there is the additional cost of such non-

1 autogenous graft materials, which can be significant.

2 Clinicians use several techniques to remove bone for grafting for intraoral  
3 procedures. In one such technique rotary instruments, such as side cutting burrs or  
4 trephines, are used to remove a piece or section of cortical bone from a local intraoral  
5 site in the maxilla or mandible. The cortical bone is often morsalized into a  
6 particulate form, either manually with a rongeur like instrument or in a bone mill. The  
7 particulate bone is then combined with blood to form an osseous coagulum, which is  
8 then positioned and packed into the osseous defect around the teeth or implant. See  
9 Robinson, R.E. "Osseous Coagulum for Bone Induction", J. Periodontology  
10 40:503(1969). Suction devices with filters have been fabricated and manufactured to  
11 collect the bone dust from rotary instruments. See Hutchinson, RA "Utilization of an  
12 Osseous Coagulum Collection Filter", J. Periodontology 44:668(1973). See also  
13 Goldman, et al., "Periodontal Therapy", pp 994-1005, C.V. Mosby Co., (1980); and  
14 Haggarty, et al., "Autogenous Bone Grafts: A Revolution in the Treatment of Vertical  
15 Bone Defects", J. Periodontology 42:626(1971). While such techniques are widely  
16 used by clinicians, the techniques have limitations, since sites to harvest sections of  
17 intraoral bone are limited in number and extent because of limited intraoral access,  
18 proximity to tooth roots, nerve structures and sinus cavities, and thin plates of bone.

19 Other techniques for harvesting bone include using chisels or osteotomes to  
20 remove and manually collect shavings from the surface. These instruments must be  
21 very sharp and the process is often awkward and time consuming. Other manual  
22 instruments such as bone files and rasps also remove bone. However, the efficiency  
23 of cutting and the ability to use the removed bone is greatly limited. Another  
24 technique is to collect bone dust generated by twist drills or taps used to prepare the  
25 sites for implant placement. However, much of the bone material may be lost while  
26 the site is being irrigated to cool the cutting instrument. When larger amounts of bone  
27 are needed for major reconstructive procedures, other sites such as the hip (anterior or  
28 posterior ilium), tibia, ribs, or the calvarium often are used. However, using such  
29 other sites necessitates a second surgical site, which may require postoperative  
30 hospitalization, and thus is less amenable, e.g. in the case of an out-patient dental  
31 procedure.

1        Various surgical devices have been proposed and/or are in use to harvest bone  
2        marrow samples for biopsy or devices such as rongeurs or bone cutters or punches to  
3        remove sections or convex edges of bone. Surgical devices also are in use in  
4        arthroscopy and endoscopy for cutting or drilling bone or tissue and removing the  
5        tissue fragments. Ultrasonic devices to cut bone also are in use; however, such  
6        devices require the removal of the irrigant and debris liberated by the apparatus. Each  
7        of these methods and/or devices, however, suffers from one or more deficiencies as  
8        applied to the collection of bone for grafting.

9        Yet other patented devices have been proposed; each of these, however,  
10      suffers from one or more deficiencies:

11        U.S. Patent Nos. 5,403,317 and 5,269,785 to Bonutti show a method and  
12      apparatus for the percutaneous cutting and removal of tissue fragments from human.  
13      The Bonutti device removes the tissue fragments by suction where it can be collected  
14      and then placed elsewhere in the patient from where originally obtained. Bonutti  
15      employs a flexible drill, and suction to remove the debris to an externally placed  
16      collection reservoir, where it is compressed before being replaced into the patient.

17        U.S. Patent No. 2,526,662 to Hipps discloses a bone meal extractor apparatus  
18      for mechanically removing bone meal from a donor bone site through a small  
19      percutaneous site using a drill. The drill shavings, which comprise primarily sub-  
20      surface bone, are then evacuated into an open cut that the drill passes through, for  
21      collection.

22        U.S. Patent No. 4,798,213 to Doppelt teaches a device for obtaining a bone  
23      biopsy for diagnosis of various bone diseases. The Doppelt device is intended to  
24      remove a core of bone using a tubular drill, while maintaining the architecture of the  
25      tissue. The sample is obtained from the marrow space and not intended from re-  
26      implantation.

27        U.S. Patent No. 5,133,359 to Kedem shows a hard tissue biopsy instrument in  
28      which samples are taken using a rotatably driven hollow needle.

29        U.S. Patent No. 4,366,822 to Altshuler discloses a method and apparatus for  
30      bone marrow cell separation and analysis. The Altshuler apparatus collects bone  
31      marrow cells in a filtration chamber on a filter interposed between a needle directed

1 into the bone marrow site and an aspirator or vacuum source, i.e. using negative  
2 pressure to withdrawal marrow cells through a needle.

3 U.S. Patent No. 5,052,411 to Schoolman teaches, a vacuum barrier attachment  
4 for shielding the operator of a medical tool from harmful aerosols and blood, etc.  
5 created by drilling, sawing types of actions, etc. The Schoolman device requires  
6 vacuum and is not intended for harvesting tissue for re-implantation.

7 U.S. Patent No. 4,722,338 to Wright et al. discloses a device instrument for  
8 removing bone that uses a shearing action similar to a rongeur to cut bone, with means  
9 for collecting fragments of bone as they are removed. The Wright et al. device  
10 reportedly is used mainly for the removal of projections or edges of bone using a  
11 shearing mechanism without the intent of harvesting the bone for grafting.

12 U.S. Patent No. 4,994,024 to Falk teaches an arthroscopy hook-clippers device  
13 that allows the unobstructed removal of tissue or bone with removal of the fragments  
14 by suction. The Falk device is intended for arthroscopy applications and with the  
15 removal of projections of tissue or bone and not specifically for the harvest of tissue  
16 for grafting.

17 Yet other prior art devices are disclosed in U.S. Patent No. 4,466,429 to  
18 Loscher et al. and U.S. Patent No. 4,844,064 to Thimsen et al.

19 The foregoing discussion of the prior art derives from my earlier PCT  
20 Application No. WO 97/11646, which describes a hand-held surgical instrument for  
21 the cutting, removal, and storage of bone surface shavings for use as autogenous bone  
22 grafts. The instrument is comprised of a blade mounted in a handle for holding and  
23 supporting said blade. The blade has a cutting structure adjacent its distal end. In a  
24 preferred form, the handle cooperates to provide a storage space adjacent the distal  
25 end of the blade for receiving harvested bone from the cutting structure. The  
26 instrument is held at an acute angle to the bone, and with minimal downward pressure,  
27 is drawn across the bone surface to cut and collect a thin shaving of bone. The blade  
28 is preferably retractable to allow the clinician access to harvested material. A plunger  
29 preferably is incorporated into the handle to serve both as a locking mechanism to  
30 secure the blade and as a means to advance and consolidate the bone in the distal  
31 aspect of the instrument.

1        The present invention provides enhanced functionality and reduced cost over  
2        the surgical instrument described in my aforesaid PCT Application No. WO  
3        97/11646.

4        The invention is directed to a hand-held surgical instrument for the cutting,  
5        removal, and storage of bone surface shavings for use as autogenous bone grafts. The  
6        instrument is comprised of a blade and storage compartment coupled to a handle. The  
7        blade may be made from a section of metal that is oriented relative to a longitudinal  
8        axis of the handle to allow the operator to more easily cut or scrape and accumulate  
9        bone. The blade preferably is slid into place over a collection chamber and secured to  
10      prevent accidental removal. The collection chamber includes storage space adjacent  
11      the cutting edge of the blade for receiving harvested bone from the blade. The  
12      collection chamber may be coupled to a handle portion at a joint. The joint allows the  
13      user to orient the blade relative to the handle in order to access hard to reach locations.  
14      A pry bar may be employed to assist in removal of the blade from the collection  
15      chamber. The pry bar may be stored within the handle portion.

16        In use, the blade and collection chamber is held at an acute angle to the bone  
17        and the user applies a minimal downward pressure as the tool is drawn across the  
18        bone surface. Thin shavings of bone are cut by the cutting edge and collected in the  
19        collection chamber. The clinician can view the amount of harvested material through  
20        an opening, preferably a slot, provided in the blade.

21        In a preferred embodiment, the blade is removable and replaceable, while the  
22        handle is reusable.

23        In another preferred embodiment of the invention, the handle has an area of  
24        reduced mechanical strength or a flexible joint displaced from the cutting edge, the  
25        area of reduced mechanical strength allowing the cutting edge to be angularly  
26        positioned relative to a longitudinal axis of the blade.

27        The above and other objects, features, and advantages of the present invention  
28        will be apparent in the following detailed description thereof when read in conjunction  
29        with the appended drawings wherein the same reference numerals denote the same or  
30        similar parts, and wherein:

31        Figure 1 is a perspective view of an exemplary bone-harvesting instrument

1 consistent with the present invention;

2 Figure 2 is an exploded view of the bone-harvesting instrument of Figure 1;

3 Figure 3 is a profile view of the bone-harvesting instrument of Figure 1;

4 Figure 4 is a perspective view of a portion of a second embodiment blade

5 consistent with the present invention;

6 Figure 5 is a an exploded view of a portion of the bone-harvesting instrument  
7 of Figure 1;

8 Figure 6 is a view similar to Figure 1 of an alternative embodiment of bone-  
9 harvesting instrument consistent with the present invention;

10 Figure 7 is a view similar to Figure 6, and illustrating loading of a blade into  
11 the handle of the instrument of the Figure 6 embodiment;

12 Figure 8 is a view similar to Figure 6 of yet another alternative embodiment of  
13 bone-harvesting instrument consistent with the present invention;

14 Figures 9, 10, 10A and 11 are views, similar to Figure 7, and illustrating  
15 loading of a blade into the handle of the instrument of the Figure 8 embodiment;

16 Figures 12-14 are views similar to Figure 7, and illustrating unloading of a  
17 blade from the handle of the instrument of the Figure 8 embodiment; and

18 Figures 15-16 illustrate packaging and handling of a blade with a hemostat.

19 Figure 1 shows a bone-harvesting instrument 100. The instrument 100 may  
20 have a handle portion 102, a collection chamber 104 and a blade 106. The handle  
21 portion 102 may have a first end 102A and a second end 102B. The handle portion  
22 102 may have a removable end cap 150 in close proximity to the first end 102A for  
23 storage of a blade removal tool 200 (see Figure 3). In one embodiment, the collection  
24 chamber 104 may be coupled to the handle portion 102 through a flexible joint 108.  
25 In a preferred embodiment of the invention, the flexible joint is an area of reduced  
26 mechanical strength. The area of reduced mechanical strength allows the cutting edge  
27 of the blade to be angularly and/or rotationally positioned or bent to a desired angle  
28 and/or position relative to a longitudinal axis of the blade 106. In another  
29 embodiment, the flexible joint may be a ball and socket joint.

30 The area of reduced mechanical strength may be an area where the thickness is  
31 less than the thickness of a surrounding area. Alternatively, the area of reduced

1 mechanical strength may be an area where the material has a lower yield strength than  
2 the surrounding area. The area of reduced mechanical strength allows the collection  
3 chamber 104 to flex or bend relative to the handle portion 102.

4 Figure 2 shows an exploded view of the instrument 100 with the blade 106  
5 spaced from the collection chamber 104. The collection chamber 104 preferably is a  
6 five-sided enclosure with a bottom 132, sidewalls 134 and an end wall 136. The  
7 interior volume of the collection chamber 104 may be used to hold accumulated bone  
8 shavings. The collection chamber 104 preferably is formed of stainless steel.  
9 Alternatively, collection chamber 104 may be molded from a polymeric material,  
10 preferably a medical grade plastic. The depth of the collection chamber 104 at the end  
11 opposite the end wall 136 preferably is less than the depth near the end wall 136. This  
12 allows the instrument to be used to access hard-to-reach locations.

13 A top surface 140 of the sidewall 134 defines a generally planar surface for  
14 supporting at least the cutting end of the blade 106. Extending from the top surface  
15 may be a pair of opposing upstanding retainer members 142 and a pair of  
16 opposing stabilizing members 144. The retainer members 142 help secure the blade  
17 106 to the collection chamber 104 during use and the stabilizing members 144 prevent  
18 the blade 106 from rotating. Each retainer member 142 includes a first cam surface  
19 142A, a second cam surface 142B, and a ledge portion 142C (see Figure 5). The  
20 ledge portion 142C helps maintain the blade 106 in contact with the top surface 140  
21 and the cam surfaces 142A and 142B help resist linear movement of the blade 106.  
22 The ledge preferably is spaced from the top surface 140 approximately the thickness  
23 of the blade 106.

24 In an alternative embodiment, a single pair of cam surfaces located on one side  
25 of the collection chamber are used to resist the linear movement of the blade 106.

26 In an alternative embodiment, a single stabilizing member, for example a post  
27 upwardly extending from the end wall 136, cooperates with an opening in the blade  
28 106 to prevent rotation of the blade 106.

29 The blade 106 may be laser cut, wire electrical discharge machined (EDM),  
30 stamped or machined from metal, preferably stainless steel, or other suitable materials  
31 with similar hardness. The blade 106 has a first end 110, a second end 112, a middle

1 section 124 and at least one outwardly extending lobe 116, preferably a pair of  
2 outwardly extending lobes. The first end 110 includes an aperture 116 adjacent at  
3 least a portion of a cutting edge 114. Thus, the cutting edge 114 is drawn along a  
4 surface, generated shavings pass through the aperture 116 and are accumulated in the  
5 collection chamber 104. An opening 118 extends along a longitudinal axis of the  
6 blade 106. The opening 118 allows the user to visually check the amount of  
7 accumulated material and also provides a spring force to allow lobe/s 116 on the blade  
8 106 to move inward to allow the blade 106 to pass the upstanding retainer members  
9 142 on the collection chamber 104.

10 The second end 112 includes a stop mechanism 120 that prevents the blade  
11 106 from traveling past its intended "use" position (see Figure 3) and a protrusion 122  
12 that can be used to help extract the blade 106 from the collection chamber 104.

13 To couple the blade 106 to the collection chamber 104, the user first aligns the  
14 lobe/s 116 in the space between the upstanding retainer members 142 and the  
15 stabilizing member/s 144. The user then applies a force (F) to the end surface of the  
16 blade 106 and directs the force along the longitudinal axis of the blade 106 towards  
17 the end wall 136. The longitudinal force causes the lobe/s 116 on the blade 106 to  
18 contact the cam surface/s 142A on the retainer member 142 of the collection chamber  
19 104. The cam surface/s 142A applies a compressive force ( $F_o$ ) to the lobe/s 116  
20 urging the lobe/s towards the centerline of the blade 106. The user continues to apply  
21 a longitudinal force to the blade 106 until the stop mechanism 120 on the blade 106  
22 contacts the end wall 136 of the collection chamber 104. The blade is now in the  
23 "use" position. In the "use" position, the lobe/s 116 preferably are partially returned  
24 to their original "relaxed" position so as to maintain a retaining force on cam surface  
25 142B.

26 A tool 200, as shown in Figure 3, may be inserted between the protrusion 122  
27 and the end wall 136 to decouple the blade 106 from the collection chamber 104. The  
28 tool 200 includes one, and preferably two prongs coupled to a handle. The prongs are  
29 spaced a distance greater than the width of the stop mechanism 120, but narrower than  
30 the width of the protrusion 122. Alternatively, a pry bar may be inserted through an  
31 opening 124 (as shown in Figure 4) in an end 112' of a blade to extract the blade 106

1 from the collection chamber 104.

2 In an alternative embodiment, a blade may be inserted from the end opposite  
3 the end wall 136 and urged towards the end wall 136. The collection chamber may  
4 include a stop mechanism that contacts a portion of the cutting end of the blade.

5 Referring to FIGS. 6 and 7, there is illustrated an alternative embodiment of  
6 bone-harvesting instrument in accordance with the present invention. In this  
7 embodiment, two cantilevered springs 21 provide opposing forces that cause retention  
8 cams 9 to bear on pin follower 10 forcing blade tabs 13 forward against forward travel  
9 stops 19 and thereby securely retain blade 2 in its forward most position (loaded). In  
10 this position, blade 2 is also constrained laterally by side guides 22 and vertically by  
11 the blade tabs 13 being under the hold-down tabs 14.

12 Referring in particular to Figure 7, blade loading is achieved by holding the  
13 blade 2 between a finger and thumb at the spring 21 end of blade 2. Then it is placed  
14 between the side guides 22 while being angled and pulled backward causing blade  
15 catches 16 to contact back travel stops 15. In this position, insertion opening 7 is  
16 aligned with pin follower 10 and blade 2 can be lowered. Next, blade ends 23 are  
17 pushed forward with a finger or thumb causing forces to be applied to insertion cams  
18 8 contacting pin follower 10. As more force is applied, the springs bend outwardly  
19 allowing blade 2 to move forward and eventually snap into loaded position as  
20 retention cams 9 bear on pin follower 10.

21 Blade removal is achieved using a prying instrument. Prying instrument 3  
22 bears against handle pry surface 11 while it is pushed backward causing force to be  
23 applied to blade pry surface 24.

24 In the embodiment shown in Figures 6 and 7, instruments may be customized  
25 at the factory by bending reduced section 25 about the X-axis and/or Y-axis. A secure  
26 rotational grip, multiple facets, enables the surgeon to control the third degree of  
27 rotational freedom by simply gripping the handle at the desired Z-axis angle.

28 In use cutting edge 114 (Figure 2) or cutting edge 17 (Figure 6) is placed in  
29 contact with the donor bone surface and pulled backward causing graft material to be  
30 cut and flow through aperture 116 (Figure 2) or aperture 18 (Figure 6) into collection  
31 chamber 104 (Figure 2) or 20 (Figure 6).

1        Harvesting progress may be monitored by looking at view slot 118 (Figure 2)  
2        or in the case of the Figure 6 embodiment, distal view slot 4, side view slots and/or  
3        proximal view slot 6 and observing graft material in or close to the slot. These slots 5  
4        are sufficiently narrow so as to prevent material from falling through them. Preferably  
5        slots 5 are in the range of 0.5 – 2 mm which is sufficient to permit the user to visually  
6        observe the graft material as it is collected, preventing material from falling through  
7        the slots. In order to better ensure material will not be lost by falling through the slots,  
8        the head of the instrument may be dipped into water or saline solution prior to use.  
9        Wetting the instrument causes the shavings to adhere to surfaces in the collection  
10      chamber.

11       After the material is harvested, the blade may be removed, and interior volume  
12      of the collection chamber may be used as a mixing area. The mixing area may be  
13      used to mix shavings of scraped bone and blood with other materials such as  
14      xenogeneic bone, allogenic bone, alloplastic material (hydroxyapatite), platelet rich  
15      plasma, and/or recombinant growth factors (BMP) to make a composition that can be  
16      later applied to an area of a patient needing a bone graft. A curette, or other standard  
17      instrument, may be used to move the graft material from the collection chamber to a  
18      desired recipient site.

19       Figures 8-16 illustrate yet another and preferred embodiment of the bone-  
20      harvesting instrument of the present invention.

21       The blade 202 in the embodiment of Figures 8-16 is similar to the blade 2 in  
22      the embodiment of Figure 7. The blade has a pair of cantilevered springs 221 which  
23      define an engagement hole 222, insertion cam 224, retention cam 226 and pin hole  
24      228 formed adjacent the approximal end of the blade. One of the blade tab ends 230  
25      includes a notch 232 or other indicia to differentiate it from the other blade tab end  
26      234 to ensure cutting edge up orientation when the blade is mounted on the handle.

27       To load the blade, the blade is picked-up adjacent its tab ends 230, 234 using,  
28      for example, a hemostat 300 (or needle holder) and the blade is positioned on the tool,  
29      e.g., as shown in Figure 10.

30       Referring to Figure 11, the hemostat 300 is re-positioned, and used to apply  
31      force against the back of the blade tab ends 230, 234 using the pin 216 for leverage.

1 The force causes the springs 221 to bend outwardly allowing blade 202 to move  
2 forward and eventually snap into loaded position as retention cams 226 bear on pin  
3 follower 210.

4 Referring to Figures 12 and 13, blade removal is achieved by inserting the  
5 nose 302 of one jaw of the hemostat 300 into an aperture 240 formed in the midpoint  
6 of the blade 202. The nose 304 of the other jaw of the hemostat is applied to bear on  
7 the pin follower 210 and the hemostat is then used to apply force to the blade to back  
8 the blade out to where the pin follower is in the engagement hole 222. Referring to  
9 Figure 14, the hemostat is then repositioned, and used to lift and remove the blade  
10 from the handle.

11 The pin follower 210 and engagement hole 222 are sized so that spring force  
12 of the cantilevered springs 221 securely hold the blade preventing it from falling off  
13 so that the blade is held in place while the hemostat is switched from holding to  
14 applying force and vice versa.

15 Figure 15 illustrates how the blade 202 is packaged in a transparent plastic bag  
16 401 and grasped with a hemostat 300 for the first time at the beginning of a grafting  
17 procedure. Figure 16 shows the hemostat 300 with lock 402 grasping the blade 202  
18 and resting flat on a table surface 403 thereby providing safe temporary storage of the  
19 blade while the handle is being used to deliver graft material. If additional graft  
20 material is needed, the surgeon picks up the hemostat with the blade already grasped  
21 and loads it onto the handle.

22 The embodiment of Figures 8-16 has several features and advantages to  
23 prevent the blade from becoming loose. For one, if the blade is inadvertently pushed  
24 backward within the range of the retention cams, the blade will be restored to its  
25 harvested position upon removal of the pushing force. The retention cams have  
26 angles sufficiently steep to create a retention force that will overcome friction and  
27 restore the blade's position. Secondly, if the blade is inadvertently pushed backward  
28 beyond the range of the retention cams, the blade can not be moved further out of  
29 position. This is because the insertion cams have angles sufficiently shallow to cause  
30 friction to retain the blade's position and not allow the spring forces to move the blade  
31 further along. Moreover, even if the blade were inadvertently forced all the back to

1 the load position, the blade still would be prevented from falling off the handle  
2 because the follower pin 216 and engagement hole 222 are sized to cause spring force  
3 from the cantilever to spring blades 221 to provide spring force in the load position  
4 (blade position shown in figure 14).

5 The bone-harvesting instrument of the present invention has many advantages.  
6 These include:

7 (1) Low cost. Only three parts are used to provide all functions:  
8       (a) cutting edge;  
9       (b) aperture;  
10      (c) collection chamber;  
11      (d) view slots;  
12      (e) graft delivery nose;  
13      (f) customized head angles; and  
14      (g) secure retention mechanism: guides, springs, cams, follower,  
15      stops, tabs, pry surfaces, etc.

16      (2) Highly secure blade retention. The angle on the face of insertion cams 8 is  
17      made shallow compared with the angle of the face on the retention cams 9. This  
18      provides relatively easy insertion and very positive retention. The prying feature  
19      allows the surgeon to easily overcome the high retention force. Additionally, handle  
20      pry surface 11 is sloped to accommodate a range of standard instrument sizes that can  
21      be used as the pry instrument 3 (see Figure 6). Thinner instruments may be positioned  
22      further down on the slope.

23      (3) Durable retention mechanism. Dual cantilevered springs apply opposing  
24      forces to the pin follower. Thus, very little force is applied to the handle material and  
25      handle wear is minimized. The pin follower can easily be made of a material that is  
26      harder than the blade (typically Rockwell 60C v. 55C) causing the blade to be the  
27      primary wearing part. Wear on the blades cams is not significant because blades may  
28      be replaced after a few uses (typically 1 to 4) to obtain new edges.

29      (4) Save and rapid blade handling. The design and the blade handling method  
30      enable the surgeon to initially grasp the blade with ease and then rapidly load and  
31      unload it from the handle without ever having to touch the small, sharp blade with his

1 fingers. Further, the method provides a convenient means to temporarily store the  
2 blade while the handle is being used to deliver graft material. Thus, the surgeon can  
3 rapidly and easily graft volumes of bone that are many times (2 – 8 or more) the  
4 volume of the collection chamber by rapidly changing from harvest mode (blade  
5 loaded) to deliver mode (blade unloaded) and vice versa.

6 (5) View slots. Slots in the blade permit viewing “through the metal” and  
7 thereby allow the blade and the handle to be made of opaque materials that are  
8 autoclaveable and reuseable.

9 (6) Angled head. Instruments can be readily customized at the users site by  
10 means of a flexible joint, e.g. ball and socket, or at the factory by bending reduced  
11 section 25 about the X-axis and/or the Y-axis. During surgery, the surgeon selects a  
12 handle with appropriate angles to facilitate access to the particular surgical site.  
13 Making all the handles the same, except for bends, enables the use of a common  
14 handle blank and a common blade. Economies of scale result from producing more of  
15 the same parts. Inventory costs also are reduced.

16 It should be understood that, while the present invention has been described in  
17 detail herein, the invention can be embodied otherwise without departing from the  
18 principles thereof, and such other embodiments are meant to come within the scope of  
19 the present invention as defined in the following claims.

20